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Circular No. 848

Physical Properties of Plated Fabrics Knit of Cotton, Wool, Viscose Rayon, and Nylon

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UNITED STATES DEPARTMENT OF AGRICULTURE

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Physical Properties of Plated Fabrics Knit of Cotton, Wool, Viscose Rayon, and Nylon

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SUMMARY

By means of plated construction, yarns and fibers can be combined in various ways to make interesting and useful knit fabrics. To obtain needed data on the physical properties of such fabrics, a study of 20 plated materials was undertaken by the Bureau of Human Nutrition and Home Economics.

The materials were knit in various combinations of cotton, wool, viscose rayon, and nylon yarns, 10 with 32 courses per inch and 10 with 40 courses per inch. For each fabric determinations were made of weight, strength, elongation, resistance to abrasion, elastic recovery, creep, creep recovery, and dimensional change in laundering. The plated fabrics were compared with plain knit fabrics with respect to elastic properties and dimensional change in laundering.

Plated fabrics were found to have quite different physical properties when knit with two yarns of different fibers than when knit with two yarns of the same fiber. For example, the plated fabrics made of all-cotton, all-wool, or all-rayon were much weaker and less resistant to abrasion than plated fabrics of all-nylon. But the plated fabrics knit of cotton, wool, or rayon combined with nylon had considerable strength and resistance to abrasion.

Neither the elastic recovery nor the creep recovery of the knit fabrics could be predicted from that of the yarns from which they were made. Whereas the wool and nylon yarns had very much higher elastic re-

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[1] Appreciation is expressed to Jane F. Gilliam, William D. Graham, and Luella S. Joiner for their assistance in determinations of creep and dimensional change.

covery than the cotton and rayon yarns, the wool fabrics had the greatest recovery and the nylon fabrics the least. The elastic recovery of the plated fabrics knit of all-wool was 90 percent at 10 percent strain in the crosswise direction, but the recovery of the all-nylon fabric was only 60 percent, which was considerably less than that of all-rayon and of all-cotton.

Elastic recovery was affected by the type of construction and by the number of courses per inch as well as by the fiber content. The plated fabrics were higher in this property than the plain knit fabrics. The materials knit with 40 courses per inch had greater recovery than those knit with 32 courses per inch.

Plated fabrics made of two yarns of different fibers often had high elastic recovery, even though yarn of one of the fibers produced fabrics of low recovery. Wool, for instance, combined with cotton, viscose rayon, or nylon produced fabrics of high elastic recovery, ranging from 80 to 91 percent for small strains in the crosswise direction for the three combinations. These values for recovery are considerably higher than those for plated fabrics of all-cotton, all-rayon, or all-nylon fabrics. The knit goods containing nylon ranked lowest in this property, ranging from 60 percent for the all-nylon material to 80 percent for the nylon-wool material.

The dimensional change caused by laundering the knit fabrics varied with the type of construction, with the number of courses per inch, and with the fiber content. The plated fabrics usually changed less in length or width than the plain knit; those knit with 40 courses per inch shrank or stretched less than those knit with 32 courses per inch. The knit materials containing wool changed the most in dimensions, and those containing nylon changed the least.

The plated fabrics were superior in many respects to plain knit goods. The plated knit goods stretched less, had greater elastic recovery, and possessed more dimensional stability in laundering than the plain knit materials made of the same yarns. The plated fabrics of which one of the yarns was wool exhibited high elastic recovery; those materials of which one of the yarns was nylon possessed considerable strength, abrasion resistance, and dimensional stability.

SCOPE OF STUDY

Plated knit fabrics afford opportunities for interesting and useful combinations of fibers and of yarns. By means of plated construction, yarn of one kind of fiber can be used on the face of the material and yarn of the same or different composition on the back. This makes possible fabrics that vary widely in appearance and other characteristics.

Since little definite information is available on the properties of such materials and how they are affected by changes in fiber content, the Bureau of Human Nutrition and Home Economics undertook a study of the physical properties of 20 plated materials knit in various combinations of cotton, wool, viscose rayon, and nylon yarns. Comparisons of the different fabrics with respect to strength elongation, weight, resistance to abrasion, elastic recovery, creep, creep recovery, and dimensional change in laundering are reported in this publication.

MATERIALS

The plated fabrics were knit in the Bureau's laboratory on a 42-gauge machine, from four commercial yarns (table 1) in 10 combinations of both 32 and 40 courses per inch. The yarns used were:

36/1 medium staple combed Peeler mercerized cotton
1/52 wool
150 denier filament viscose rayon
150 denier filament nylon.

The twist of the cotton yarn was 17 turns per inch, and of the wool 15 turns per inch. The rayon and nylon yarns as purchased had little twist. In order to facilitate knitting they were first processed with a waxed treatment and given a twist of approximately 10 turns per inch.

Table 1.—*Properties of yarns*

Yarn	Yarn number [1]		Twist [2]			Breaking strength [3]		Breaking elongation [3]	
	Labeled	Experimental	Direction	Mean turns per inch	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
		Grex		*Number*	*Number*	*Grams*	*Grams*	*Percent*	*Percent*
Mercerized cotton	36/1 cotton	164.0	Z	17.3	2.0	237.6	24.9	4.45	0.47
Wool	1/52 worsted	180.6	Z	15.3	2.2	97.7	17.0	13.68	4.29
Viscose rayon	150 denier	184.5	S	7.6	1.1	260.8	10.6	16.97	1.27
Nylon	150 denier	198.2	S	10.6	.4	974.6	49.8	14.50	.83

[1] Mean of 10 determinations.
[2] Mean and standard deviation of 20 determinations.
[3] Mean and standard deviation of 70 determinations.

For each fabric two yarns were used. One was laid so that it appeared only on the purled side of the material while the other was guided to the knitted side. Fabrics were knit in the following combinations of yarns:

Yarn appearing on knit side of fabric	*Yarn appearing on purled side of fabric*
Cotton	Cotton
Wool	Cotton
Rayon	Cotton
Nylon	Cotton
Wool	Wool
Rayon	Wool
Nylon	Wool
Rayon	Rayon
Nylon	Rayon
Nylon	Nylon

Plain fabrics of 32 and 40 courses per inch, were also knit from the same four yarns in order to compare their elastic properties and dimensional stability with those of the plated materials.

PREPARATION OF FABRICS

The fabrics were immersed for 1 hour in an organic solvent to dissolve the natural wax as well as that applied before the knitting, and then rinsed in distilled water at 100° F. They were then laundered in a small washing machine that had a rotating cylinder 12 inches high and 9 inches in diameter. They were washed for 30 minutes at 100° with a 0.5 percent solution of neutral soap in distilled water and rinsed in distilled water of the same temperature. After rinsing they were squeezed by hand and laid out smoothly, without stretching, on a flat surface and allowed to dry. Care was taken not to distort the fabric before testing because any applied stress would change the elastic properties.

Before any physical determinations were made, the fabrics were allowed to come to equilibrium with an atmosphere having a relative humidity of 65 percent and a temperature of 70°.

METHODS USED IN DETERMINING YARN AND FABRIC PROPERTIES

Weight, Strength, Elongation, and Resistance to Abrasion

The weight per square yard of the fabrics was obtained by weighing 2-inch squares, cut on the diagonal with a steel die, on a torsion balance calibrated in ounces per square yard.

For yarns, the breaking strength and elongation were determined by using the Scott incline plane serigraph tester. For fabrics, the bursting strength and elongation determinations were made with a Scott ball-burst attachment on the regular Scott strength tester.

The Taber abraser with hosiery attachment (*6*)[2] was used in determining the resistance of the fabric to abrasion. Each of the abrading wheels exerted a pressure of 500 gm. against the specimen. Five pieces of fabric, each 7 inches square, were used for these determinations. Since the attachment had eight sections, each sample furnished eight specimens, making a total of 40 determinations for every fabric. The number of cycles was noted when the first hole appeared in each section.

Elastic Recovery of Yarns

Instantaneous elastic recovery and the combined instantaneous and delayed recovery were determined for the four knitting yarns. Instantaneous elastic recovery was calculated from hysteresis loading curves. These curves were formed by the incline plane machine employed in determining the breaking strength and elongation of the yarns. A gauge length of 20 inches was used for these measurements instead of the usual 10-inch length.

Five cyclic stress-strain curves were made for each specimen. Before a test was started, the machine was set for a definite maximum load, and the setting was not changed until five specimens had been examined.

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[2] Italic numbers in parentheses refer to Literature Cited, p. 26.

The total stretch and recoverable stretch were read from the cyclic stress-strain diagram, and the elastic recovery was calculated as the ratio of recoverable stretch to total stretch. The means of stretch and elastic recovery at the same maximum load for the fifth cycle of loading were obtained for the five specimens. The results for three or more maximum loads were used in plotting elastic recovery-strain curves.

Figure 1 shows hysteresis loops of stress-strain curves of the wool yarn at a maximum load of 75 gm. The total and elastic stretch are indicated for the fifth cycle.

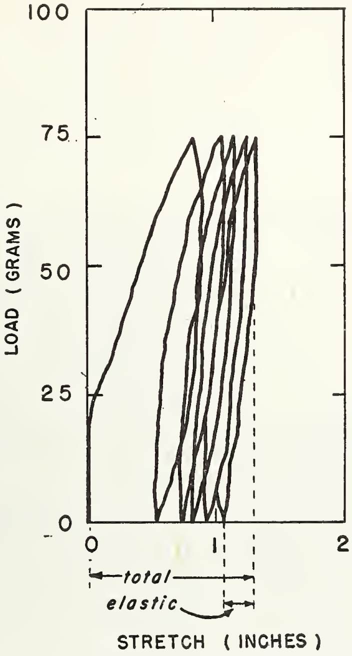

FIGURE 1.—Cyclic stress-strain curves of wool yarn at a maximum load of 75 gm.

In determining the combined instantaneous and delayed recovery, the yarn was securely clamped in a horizontal position with the end passing over a frictionless pulley. With an initial load of 1 gm., a gauge length of 20 inches was marked off from the clamped end. Then a small additional load was applied to the yarn. After 10 seconds, the elongation of the 20-inch length was read and the additional load removed, leaving only the initial 1-gm. load. Fifteen seconds later, the amount of stretch was noted.

From the measurements taken under different loads, the total stretch, recoverable stretch, and elastic recovery were calculated. This procedure was repeated with various loads, using three specimens of each of the four yarns. The loads for cotton ranged from 40 to 120 gm.; for wool, 5 to 60; for rayon, 50 to 150; and for nylon, 50 to 500 gm.

Elastic Recovery of Fabrics

Instantaneous recovery of the knit fabrics was calculated from hysteresis stress-strain curves formed by the incline plane machine used in determining the breaking strength and the instantaneous elastic recovery of the yarns. The procedure was similar to that just described for the yarns and has been previously reported in detail (*2*, *5*).

The combined instantaneous and delayed recovery of the fabrics was determined by a procedure recently developed by the authors (*3*). Figure 2 shows the apparatus with a specimen inserted and marked for measuring stretch and elastic recovery. For the crosswise measurements, the specimen was cut 12 by 8 inches with the shorter dimension parallel to the lengthwise direction of the knit fabric; for the lengthwise measurements, the fabric was cut with the shorter dimension parallel to the crosswise direction of the fabric. Twelve pins in a 5-inch length held the specimen in place.

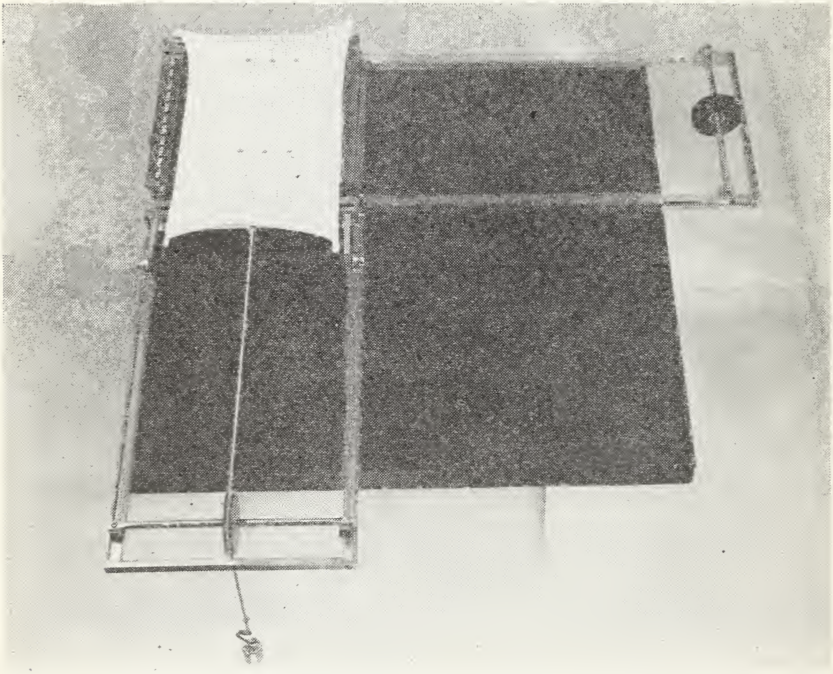

Figure 2.—Elasticity apparatus with specimen of knit fabric inserted and marked for measuring stretch and elastic recovery.

Three 5-inch lengths were marked off while the fabric was held taut by an initial load of 50 gm. The initial load was removed and a 200-gm. load applied. At the end of 10 seconds, the three marked lengths were measured. Then the 200-gm. weight was replaced by the 50-gm. weight. Fifteen seconds after the 200-gm. weight was removed, the same three places were again measured. From the readings taken under different loads, the total stretch, recoverable stretch, and elastic recovery were calculated. This procedure was repeated with loads of 300, 400, 500, 650, 800, 1,000, 1,250, 1,750, 2,000 gm., using three specimens of each fabric.

Results of elastic recovery determined from three specimens varied somewhat but the mean recovery for three specimens varied little from the mean recovery of three other specimens. Figure 3 shows the variation in results of three specimens and the close agreement of the means of two separate sets of means, which indicate good reproducibility.

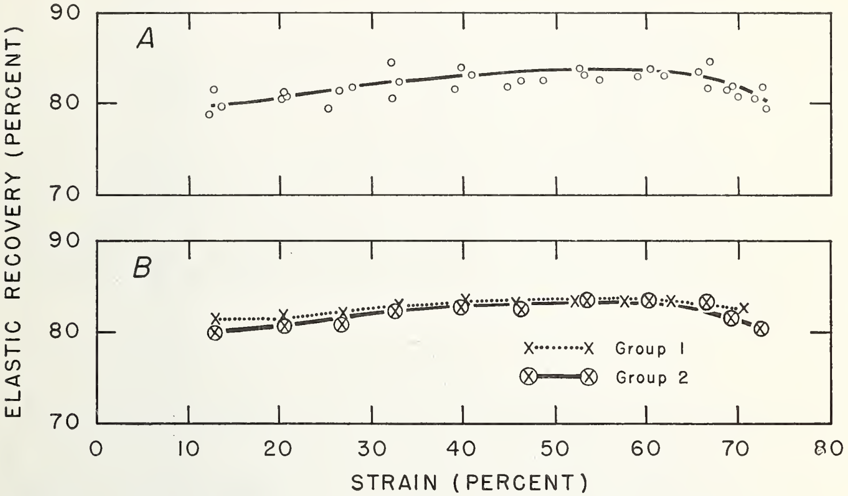

Figure 3.—Combined instantaneous and delayed elastic recovery, crosswise, for nylon-wool plated fabric knit with 32 courses per inch: A, determined from the mean of three specimens; B, determined by two groups of three specimens each.

Creep and Creep Recovery of Yarns and Fabrics

For creep and creep recovery measurements of the yarns, a 20-inch gauge length was marked off with an initial load of 1 gm. An additional load was then added and readings were made of the creep elongation at the end of 1 minute and at intervals of 1, 2, 3, 5, 10, and 20 minutes up to 100 minutes. An additional load of 40 gm. was used for the cotton, 20 for the wool, 50 and 100 for the viscose rayon, and 50, 100, and 200 for the nylon.

Recovery measurements were made after the creep determinations were taken. This was done in the stress-relaxation experiments by removing the load and taking readings of the length with only the initial load of 1 gm.

In making creep and creep recovery determinations of the fabrics, specimens similar to those for making the elastic recovery measurements were used. After the specimens were placed on the pins of the elasticity machine, an initial load of 50 gm. was applied, and a 5-inch length was marked off on the sample. The initial load was replaced by one of the 400 gm., and readings were made of the 5-inch length at the end of 1 minute and at various intervals for 100 minutes.

After the creep measurement of a specimen was made, the 400-gm. load was removed and the fabric was allowed to relax for 1 minute. The 50-gm. load was then applied and the reading was taken of the marked length. Then the 50-gm. load was removed and applied only at the regular intervals when the readings were taken. Three replicates of each fabric were used for the creep and creep recovery measurements just as for elastic recovery.

Dimensional Change of Fabrics in Laundering

Three specimens, 12 by 12 inches, of each of the 20 plated and 8 plain knit fabrics were used in making the measurements to determine dimensional changes in laundering. Before the specimens were degreased or laundered, three 5-inch lengths were marked on both the lengthwise and crosswise directions.

For marking before laundering and for measuring changes in dimensions after laundering, the fabric was placed on pins of the apparatus used in evaluating the elastic properties of knit fabrics. All measurements were made with a load of 50 gm. in both directions. The measuring procedure was repeated after each of five successive washings.

RESULTS

Weight, Strength, Elongation, and Resistance to Abrasion

Analysis of the data shows that the plated fabrics knit with 40 courses per inch were heavier, stronger, and more resistant to abrasion than those knit with 32 courses per inch (table 2). In general, the materials knit with 32 courses per inch elongated at rupture nearly the same amount as those knit with 40 courses per inch.

When dry, the wool-wool material had by far the lowest bursting strength and the nylon-nylon fabric much the highest strength in each of the two groups of plated materials. When wet, the wool-wool plated fabric knit with 32 courses per inch was the weakest, but in fabrics knit with 40 courses per inch, the rayon-wool material had the lowest bursting strength. Of the fabrics containing cotton, the wool-cotton materials were the weakest and the nylon-cotton the strongest, irrespective of construction or the amount of moisture. Likewise, the rayon-wool was the weakest and the nylon-rayon the strongest of the fabrics containing rayon. When dry, the nylon-wool fabrics ranked next to the nylon-nylon in strength, but when wet the nylon-cottons were next to the strongest materials.

In abrasion resistance the materials knit with 32 and with 40 courses per inch differed with the fiber content. In both groups the nylon-nylon fabric was the most resistant. The fabrics containing nylon were more resistant to abrasion than the other combinations; the wool-wool fabric ranked next to the nylon mixtures; the rayon-cotton fabric was the least resistant to abrasion.

TABLE 2.—*Properties of plated fabrics knit with 32 and 40 courses per inch*

Fabric	Weight per square yard [1]	Bursting strength [2]				Elongation [2]				Resistance to abrasion [3]	
		Dry		Wet		Dry		Wet			
		Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Knit with 32 courses per inch:	*Ounces*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Inches*	*Inches*	*Inches*	*Inches*	*Cycles*	*Cycles*
Cotton—cotton	4. 36	81. 20	10. 09	95. 60	5. 07	0. 212	0. 027	0. 301	0. 036	519. 9	186. 6
Wool—cotton	5. 38	45. 75	3. 84	39. 25	3. 23	. 191	. 056	. 232	. 027	548. 0	172. 1
Rayon—cotton	5. 68	56. 75	8. 97	44. 35	3. 45	. 381	. 105	. 204	. 036	378. 6	185. 7
Nylon—cotton	5. 90	146. 20	8. 98	143. 50	14. 15	. 273	. 028	. 317	. 094	1, 711. 1	640. 5
Wool—wool	5. 58	20. 70	4. 60	19. 45	2. 60	. 345	. 098	. 486	. 073	791. 4	257. 6
Rayon—wool	5. 12	43. 50	2. 05	19. 75	2. 06	. 256	. 027	. 291	. 049	539. 5	179. 7
Nylon—wool	4. 90	150. 05	5. 87	113. 50	8. 13	. 468	. 055	. 484	. 045	1, 822. 6	433. 5
Rayon—rayon	5. 12	63. 65	5. 25	31. 10	. 99	. 333	. 040	. 327	. 036	507. 8	166. 6
Nylon—rayon	4. 74	120. 75	8. 70	120. 65	7. 37	. 436	. 144	. 475	. 121	1, 858. 8	607. 5
Nylon—nylon	5. 32	222. 35	34. 80	238. 00	36. 19	. 530	. 192	. 465	. 089	1, 862. 4	695. 2
Knit with 40 courses per inch:											
Cotton—cotton	5. 20	87. 75	12. 10	108. 90	10. 41	. 272	. 044	. 362	. 047	833. 9	284. 3
Wool—cotton	6. 22	53. 80	6. 78	46. 55	5. 42	. 193	. 036	. 246	. 052	943. 8	286. 2
Rayon—cotton	6. 36	70. 85	4. 27	49. 65	4. 68	. 259	. 024	. 231	. 046	515. 7	247. 1
Nylon—cotton	6. 50	159. 65	6. 00	165. 00	9. 12	. 272	. 023	. 327	. 031	2, 810. 7	1, 280. 7
Wool—wool	6. 12	40. 55	3. 96	25. 80	3. 15	. 322	. 080	. 734	. 119	1, 076. 4	333. 2
Rayon—wool	6. 12	45. 15	3. 07	22. 10	. 88	. 254	. 030	. 297	. 029	855. 8	299. 4
Nylon—wool	5. 94	162. 85	5. 86	134. 40	8. 14	. 508	. 060	. 516	. 068	3, 156. 4	1, 034. 7
Rayon—rayon	6. 12	71. 45	6. 79	36. 80	1. 30	. 396	. 047	. 494	. 048	777. 9	284. 1
Nylon—rayon	5. 84	143. 75	9. 44	142. 45	8. 30	. 445	. 043	. 514	. 051	2, 501. 4	783. 8
Nylon—nylon	5. 94	275. 40	3. 18	274. 10	23. 66	. 580	. 063	. 649	. 108	4, 087. 9	1, 387. 6

[1] Mean of 5 determinations.
[2] Mean and standard deviation of 10 determinations.
[3] Mean and standard deviation of 40 determinations.

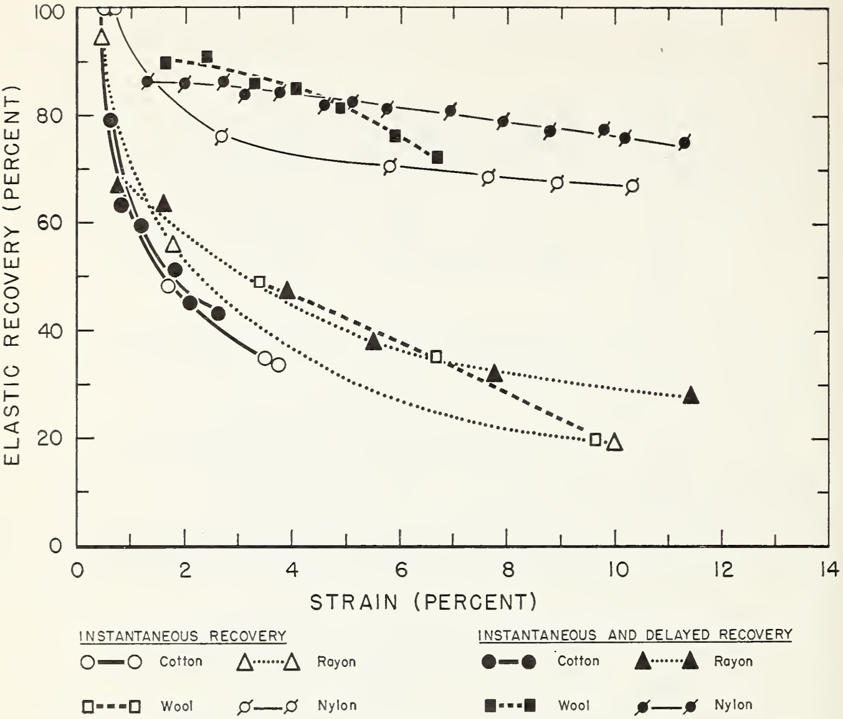

Figure 4.—Instantaneous and combined instantaneous and delayed elastic recovery of yarns: Cotton, wool, viscose rayon, nylon.

Elastic Recovery of Yarns

Figure 4 shows the elastic recovery for various amounts of strain for the cotton, wool, viscose rayon, and nylon yarns. The nylon had the greatest instantaneous recovery (100 to 67 percent) and cotton the least (100 to 33 percent). The nylon and wool were similar in combined instantaneous and delayed recovery and had greater combined recovery than either the rayon or cotton. The rayon had greater combined recovery than the cotton.

For all the yarns except the cotton, instantaneous recovery and combined instantaneous and delayed recovery differed considerably. The cotton had a negligible amount of delayed recovery. Even though the combined recovery of the wool yarn was equal to that of the nylon yarn (83 percent) for 4.5 percent strain, the instantaneous recovery of nylon (72.5 percent) was nearly twice as great as the instantaneous recovery of the wool yarn (44 percent) for 4.5 percent strain.

Elastic Recovery of Fabrics

For the knit fabrics, the combined instantaneous and delayed recovery was considerably more than the instantaneous recovery. Figure 5 shows the results for the plain knit fabrics of 32 courses per inch. For a strain of 70 percent the instantaneous recovery for the cotton, wool, rayon, and nylon fabrics was respectively 26, 48, 24, and 19 percent, whereas the combined instantaneous and delayed recovery was 56, 80, 55, and 59 percent, respectively. The combined instantaneous and delayed recovery of the cotton and rayon plain knit fabrics decreased considerably with an increase in strain. Even though the nylon fabric had much less recovery for a small strain, its recovery did not decrease with strain; for large strains it was somewhat superior to the cotton and rayon in this property. Over the range measured, instantaneous recovery of the wool and nylon fabrics did not decrease with an increase of strain. The cotton and rayon materials decreased in instantaneous recovery with an increase in strain and for large strains had the least recovery. The wool was superior to all the fabrics in both instantaneous recovery and combined instantaneous and delayed recovery.

Since total recovery rather than merely instantaneous recovery, determines the usefulness of knit fabrics for a specific purpose, only the combined recovery was measured for all plated fabrics and for the plain knit fabrics of 40 courses per inch.

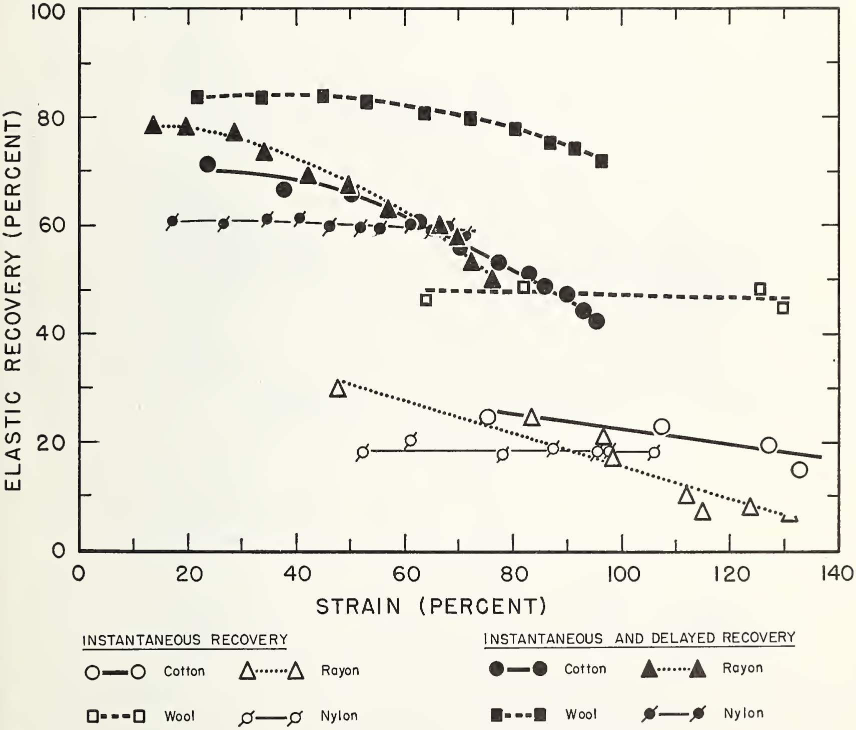

Figure 5.—Instantaneous and combined instantaneous and delayed elastic recovery, crosswise, of plain knit fabrics, 32 courses per inch: Cotton, wool, viscose rayon, nylon.

FABRICS OF SINGLE FIBER CONTENT

Plated and plain knit fabrics of cotton, wool, viscose rayon, and nylon fabrics differed in elastic recovery with: (1) Fiber content, (2) number of courses per inch, and (3) lengthwise and crosswise directions (figs. 6, 7).

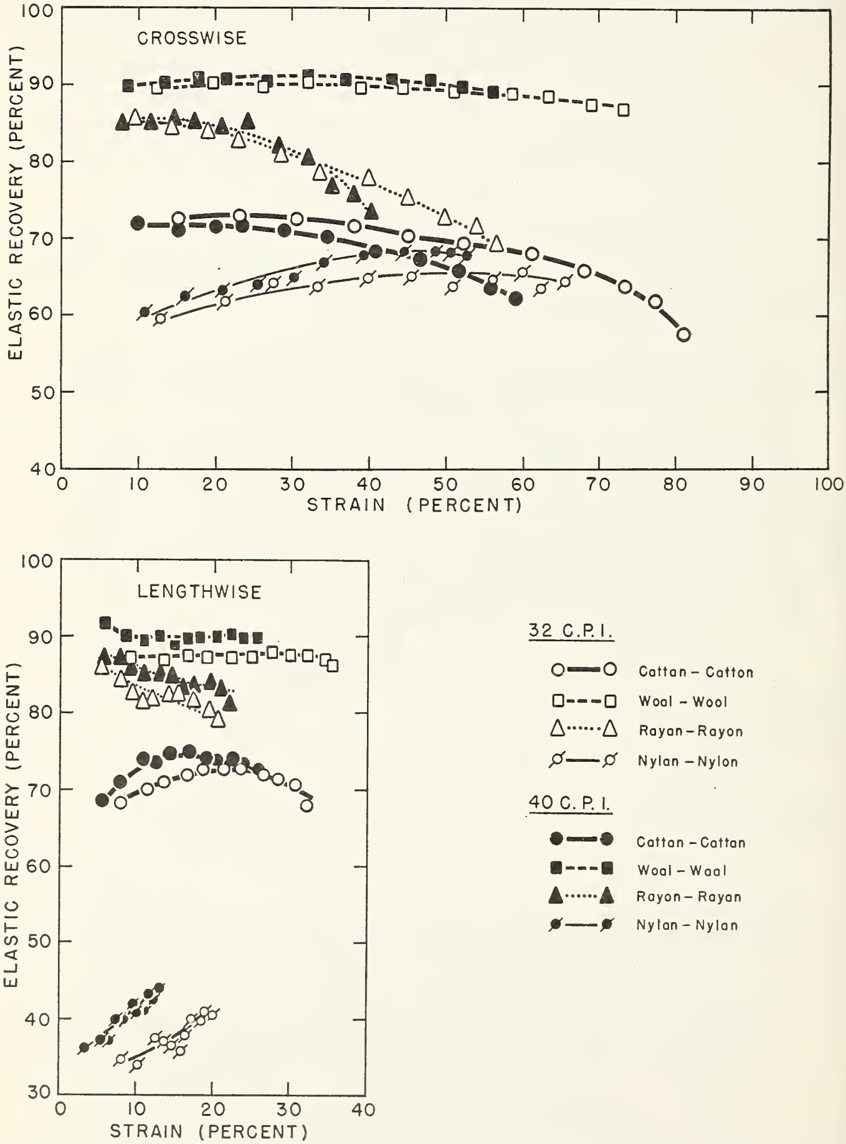

Figure 6.—Total elastic recovery, crosswise and lengthwise, of plated fabrics knit entirely of one fiber, 32 and 40 courses per inch: Cotton, wool, viscose rayon, nylon.

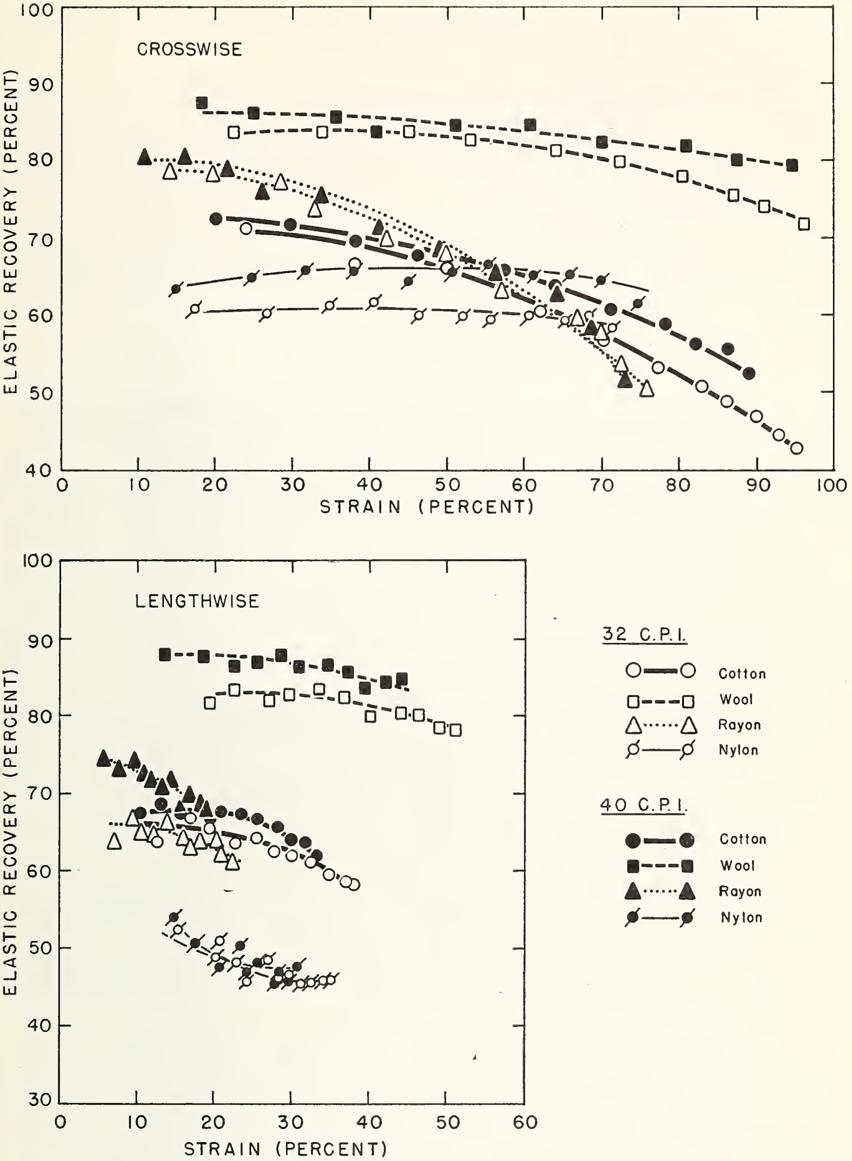

FIGURE 7.—Total elastic recovery, crosswise and lengthwise, of plain knit fabrics. 32 and 40 courses per inch: Cotton, wool, viscose rayon, nylon.

Of the plain knit and plated fabrics of a single fiber content, those of wool had considerably more recovery than the others. With small amounts of strain, the nylon fabrics had the least recovery. The viscose rayon and the cotton fabrics decreased in recovery with increased strain; with large amounts of strain all except the plated rayon had less recovery in the crosswise direction than did nylon. In general, the plated fabrics had greater recovery than the plain knit fabrics in the crosswise direction.

All the fabrics stretched less in length than in width. The lengthwise recovery of the plated fabrics, with the exception of nylon, was greater than that of plain knit fabrics. For the plated nylon, lengthwise recovery was only 40 percent, considerably less than that of the other plated fabrics.

The fabrics knit with 40 courses per inch usually had greater recovery than those knit with 32 courses per inch. However, in the crosswise direction, the plated cotton of 32 courses per inch had greater recovery than that of 40 courses per inch.

PLATED FABRICS OF TWO FIBERS

Elastic recovery in the crosswise direction for plated fabrics of two fibers, knit with 32 and 40 courses per inch, in shown in figure 8.

Fabrics containing cotton.—Of the plated fabrics containing cotton, the wool-cotton and rayon-cotton combinations showed greater recovery than the cotton-cotton material. The nylon-cotton reacted similarly to the cotton-cotton fabric.

In the lengthwise direction the range in recovery of the rayon-cotton, cotton-cotton, and nylon-cotton was from 75 to 65 percent. The recovery of the wool-cotton of 40 courses per inch was 85 percent and the wool-cotton of 32 courses per inch was 80 percent.

Fabrics containing wool.—Elastic recovery in the crosswise direction of the plated fabrics containing wool ranged from 80 percent for the nylon-wool to 90 percent for the wool-wool. Combining wool with yarns having less recovery produced fabrics having relatively high recovery, though not as high as that of wool-wool. The materials knit with 32 and 40 courses per inch were not significantly different in recovery in width.

In length the wool-rayon, wool-cotton, and wool-wool ranged in elastic recovery from 80 to 90 percent. As strain increased the nylon-wools of 32 and 40 courses per inch increased in recovery from 75 to 77 and from 77 to 80 percent, respectively. In each of these combinations, the material knit with 40 courses per inch had greater recovery than those of 32 courses per inch.

Fabrics containing rayon.—The range of recovery of the plated fabrics containing rayon was between 85 and 70 percent in the width, which was the range for the rayon-rayon from small to large strains. Combining wool with the rayon produced a fabric which decreased little in recovery with strain. The rayon combined with cotton and with nylon produced fabrics having greater recovery than either cotton-cotton or nylon-nylon (fig. 6). The materials knit with 32 and 40 courses per inch were not significantly different in recovery in width.

In length, the elastic recovery of all the fabrics containing rayon ranged between 65 and 85 percent except nylon-rayon of 32 courses per inch which had a recovery of only 50 percent. All had greater recovery in length when knit with 40 courses per inch than when knit with 32 courses.

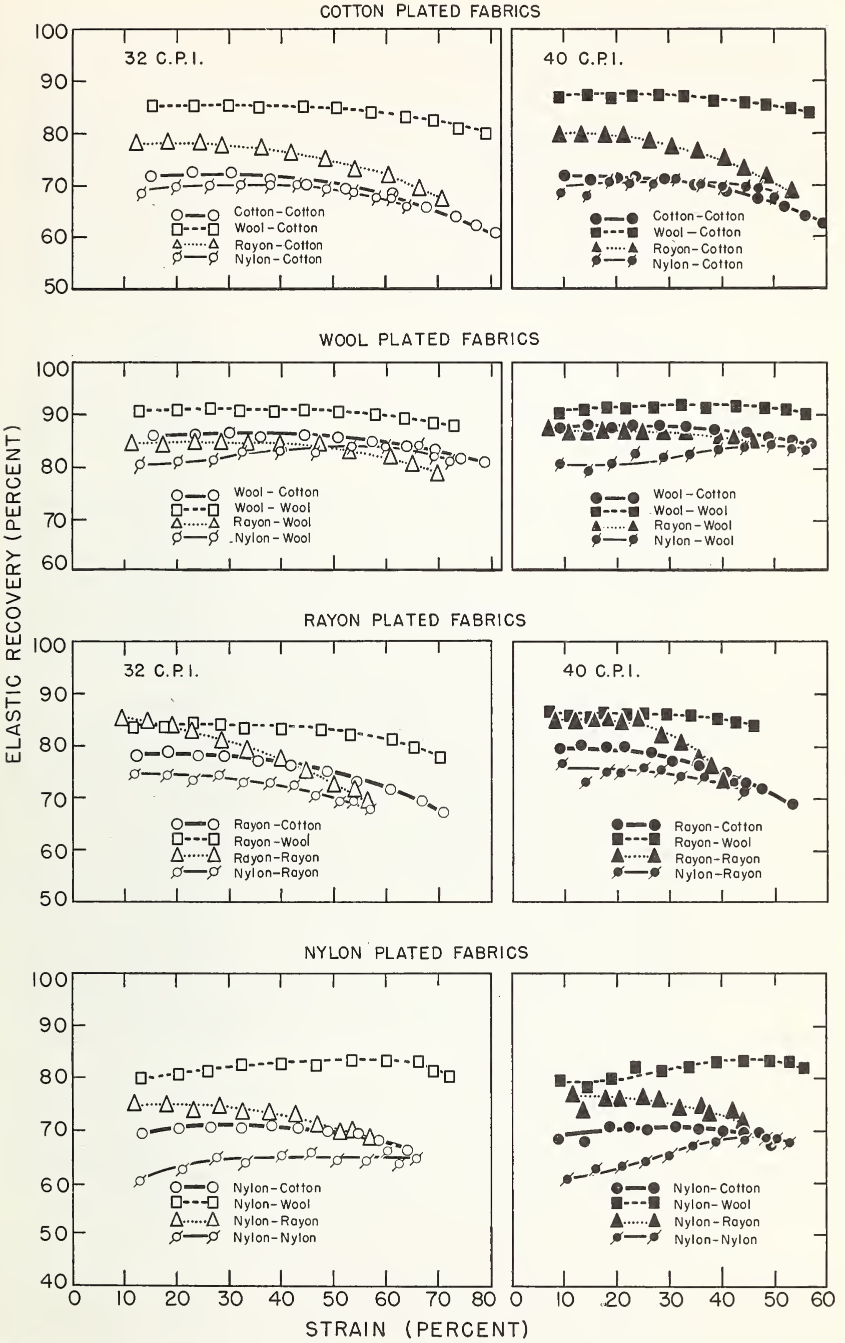

FIGURE 8.—Total elastic recovery, crosswise, of plated fabrics knit with two fibers, 32 and 40 courses per inch: Cotton, wool, viscose rayon, and nylon, each in combination with cotton, wool, viscose rayon, and nylon.

Fabrics containing nylon.—In width, the range in elastic recovery of the plated fabrics containing nylon was between 60 and 84 percent. Combining wool, cotton, or rayon with nylon produced fabrics with greater recovery than that of the nylon-nylon material. The fabrics containing the nylon yarn decreased less in recovery with strain than the cotton-cotton or rayon-rayon; the nylon-wool and nylon-nylon increased in recovery with strain. In width there was little difference in recovery between those knit with 32 and 40 courses per inch.

The recovery in length of the fabrics containing nylon ranged between 35 and 80 percent. The fabrics knit with 40 courses per inch exhibited considerably greater recovery than those of 32 courses per inch.

Creep and Creep Recovery of Yarns and Fabrics

Both yarns and knit fabrics exhibited the slow progressive deformation under constant load known as creep. Also, all showed considerable recovery from deformation during the 100-minute interval when stresses were removed.

The yarns differed considerably in performance, particularly the rayon and nylon (fig. 9). These had high initial elongations (rayon, 0.85 and 5.95 percent with stresses of 50 and 100 gm.; nylon, 1.3, 3.1, and 6.15 percent with stresses of 50, 100, and 200 gm.). After relaxation of the stresses, elongations of the nylon yarn did not differ greatly; they were 0.15, 0.2, and 0.5 percent. In contrast, the rayon yarns showed considerable difference in elongations (0.45 and 5.35 percent) when the stresses of 50 and 100 gm. were released.

Elongation of the cotton yarn after the relaxation of a 40-gm. stress was 0.1 percent. Wool, which had an initial elongation of 3.0 percent under a load of 20 gm., had an elongation of 0.75 percent after the load was released. The low recovery of the wool yarn may have been caused partially by fiber slippage.

Of all the knit fabrics of single fiber content, both plated and plain knit, the cotton elongated the most and rayon the least in the creep experiments; the wool recovered the most in the stress-relaxation experiments (fig. 10).

At the end of the 100-minute relaxation interval all plain knit fabrics of 32 courses per inch, except the wool, were greatly elongated (8 to 17 percent). The cotton, rayon, and nylon of 40 courses per inch were about equally elongated but to a much lesser extent (2.5 to 3.5 percent) than those knit with 32 courses.

The creep recoveries of the plated fabrics at the end of the 100-minute relaxation period were about the same regardless of courses per inch. The ranges of elongation were 1 to 3 percent for materials of 32 courses per inch and 0.5 to 2.5 percent for those of 40 courses per inch.

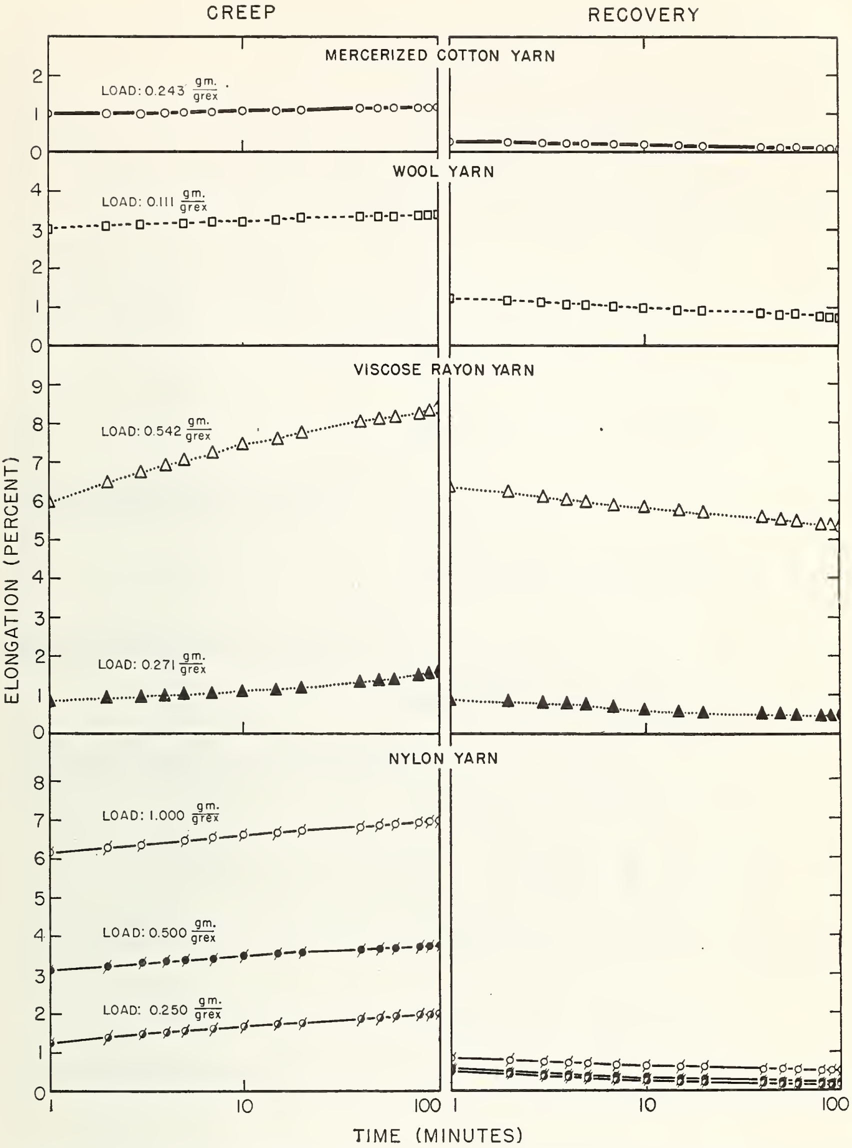

FIGURE 9.—Creep and creep recovery of yarns: Cotton, wool, viscose rayon, nylon. Creep took place under the following gram loads: 40 (cotton); 20 (wool); 50 and 100 (viscose rayon); 50, 100, and 200 (nylon).

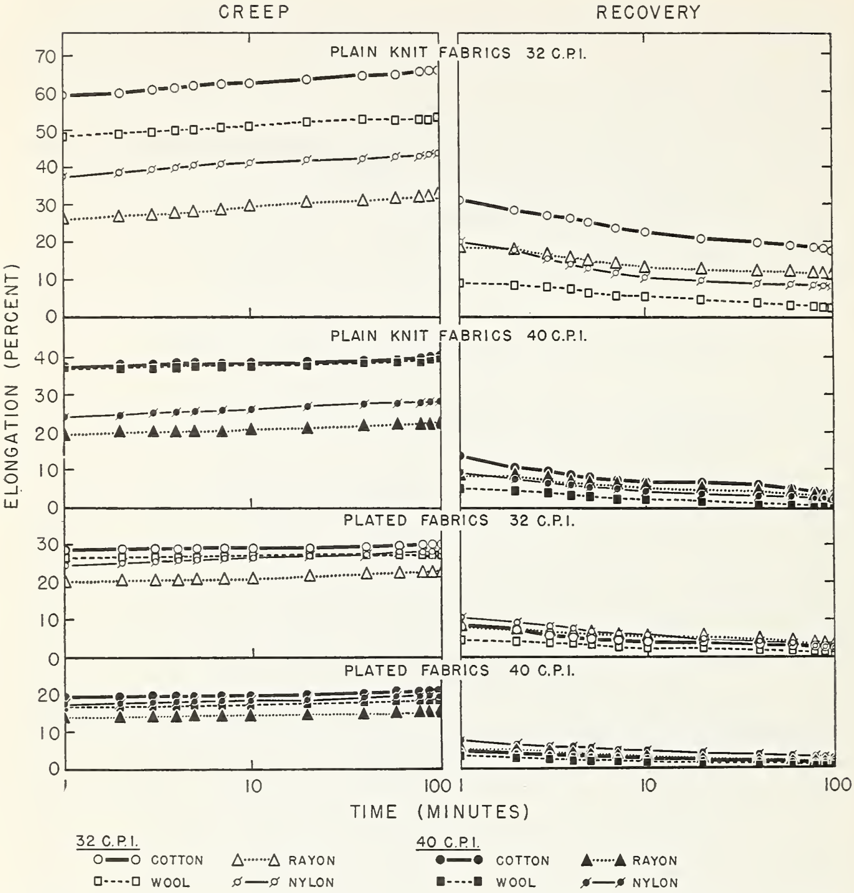

Figure 10.—Creep and creep recovery of plated fabrics knit entirely of one fiber and plain knit fabrics, 32 and 40 courses per inch: Cotton, wool, viscose rayon, nylon.

Dimensional Change of Fabrics in Laundering

Results of the study of dimensional change of fabrics in laundering are presented in figures 11 to 16.

FABRICS OF SINGLE FIBER CONTENT

In general, the plain knit fabrics exhibited greater dimensional changes in the five launderings than did the plated fabrics of single fiber content (figs. 11, 12). The viscose rayon material was an exception; the plain knit rayon shrank less than the plated. All the fabrics knit with 32 courses per inch shrank more in length than those of 40 courses; all except the wool stretched in width. Many of the fabrics of 40 courses per inch shrank in width but none stretched excessively.

PLATED FABRICS OF TWO FIBERS

The plated fabrics of the 10 combinations of wool, cotton, viscose rayon, and nylon knit with 32 courses per inch changed more in length and width than those knit with 40 courses per inch (figs. 13 to 16). These results are in line with those reported on shrinkage of wool knit fabrics by Dutton who stated that length relaxation increases and width relaxation decreases with a decrease in the number of courses per inch (*1*).

All the plated fabrics except the nylon-nylon of 40 courses per inch shrank in length. Many knit with 32 courses per inch stretched in width, but none shrank excessively in that direction. All plated fabrics knit with 40 courses per inch except the all-cotton, all-wool, and cotton and wool, shrank in width.

The greatest change usually took place in the first laundering and leveled off after the second or third laundering. However, progressive shrinkage in length was quite pronounced throughout the five successive launderings in all the plated fabrics containing wool knit with 32 courses per inch, and in the wool-wool and wool-cotton fabrics knit with 40 courses per inch.

Of the 10 combinations knit with 32 courses per inch, the plated fabrics containing wool showed the greatest dimensional change in laundering. In length shrinkage ranged from 10 to 20 percent, and in width the change ranged from 7 percent stretch to 2 percent shrinkage. The group of materials containing nylon changed the least both in length and in width. The length shrinkage ranged from 5 to 10 percent, and in width the changes ranged between 2.5 percent stretch and 2 percent shrinkage.

Likewise, the group of plated fabrics containing wool knit with 40 courses per inch had the greatest dimensional change in laundering and the group containing nylon had the least. The length shrinkage of the wool materials ranged from 3 to 12 percent, and that of the nylon, from 0 to 5 percent. In width the change in the wool ranged from 1.5 percent stretch to 6.5 percent shrinkage; the change in width of the nylon ranged from 4 to 7 percent shrinkage.

The data on lengthwise shrinkage show that the plated fabrics knit with 32 courses per inch, except those containing nylon, shrank more in length than did certain woven fabrics of cotton, wool, and viscose rayon that were laundered by standard test procedures in the Bureau's laboratory in a previous study (*4*). Most of the woven cottons and rayons shrank less than 8 percent in length, whereas most of the knit fabrics in the cotton and rayon groups shrank more than 8 percent (figs. 13, 14). In a group of five woven wool materials four shrank approximately 15 percent, which is not as high as the shrinkage of three of the fabrics in the knit wool group (fig. 14). On the other hand, 6 out of the 10 combinations of plated fabrics knit with 40 courses per inch shrank 8 percent or less, and none shrank more than 12 percent (fig. 15).

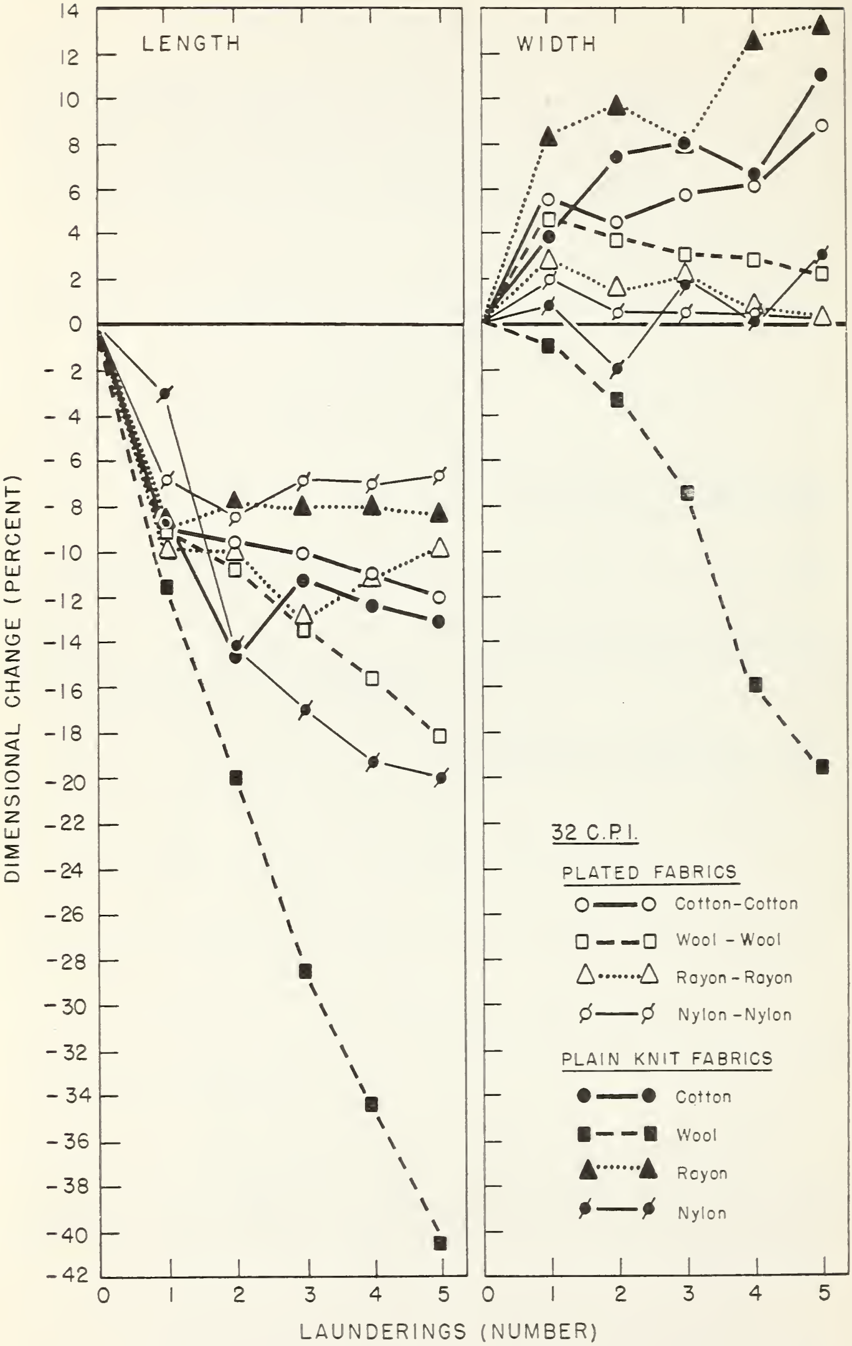

FIGURE 11.—Dimensional change in five launderings of plated fabrics knit entirely of one fiber and plain knit fabrics, 32 courses per inch: Cotton, wool, viscose rayon, nylon.

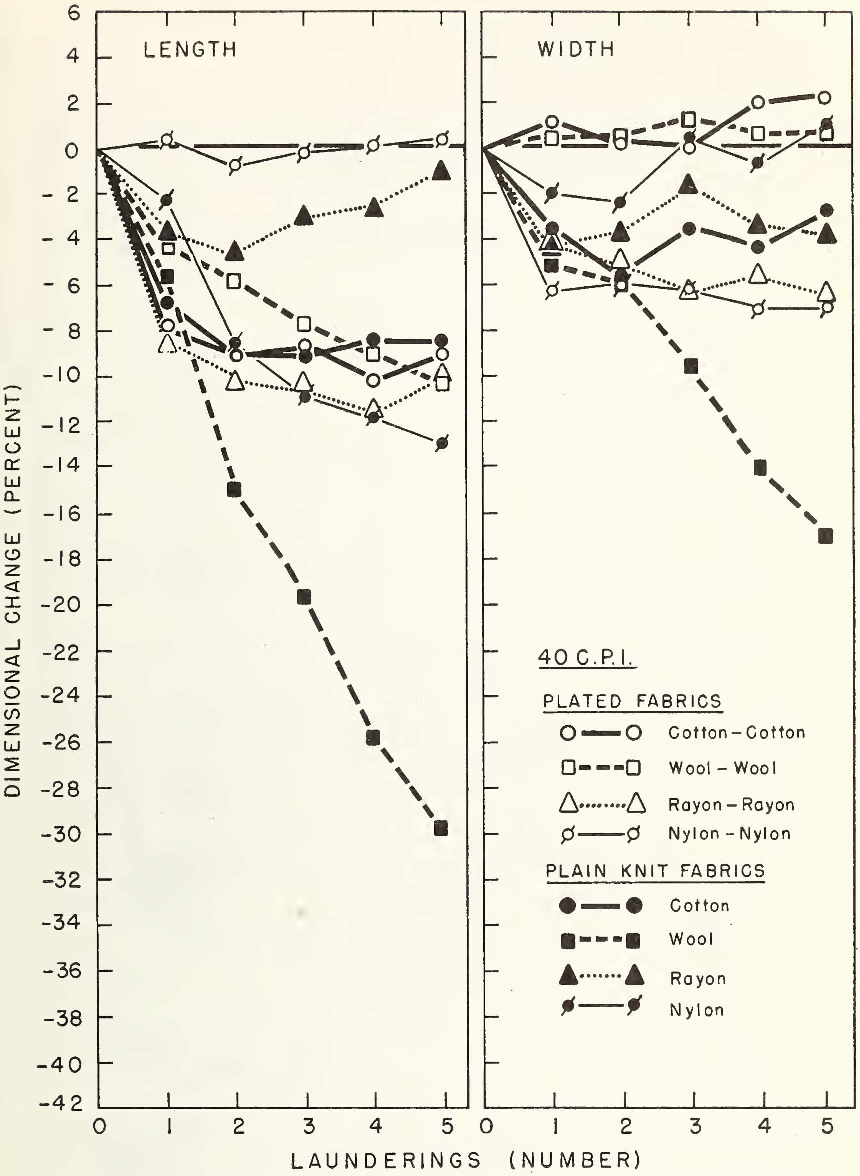

FIGURE 12.—Dimensional change in five launderings of plated fabrics knit entirely of one fiber and plain knit fabrics, 40 courses per inch: Cotton, wool, viscose rayon, nylon.

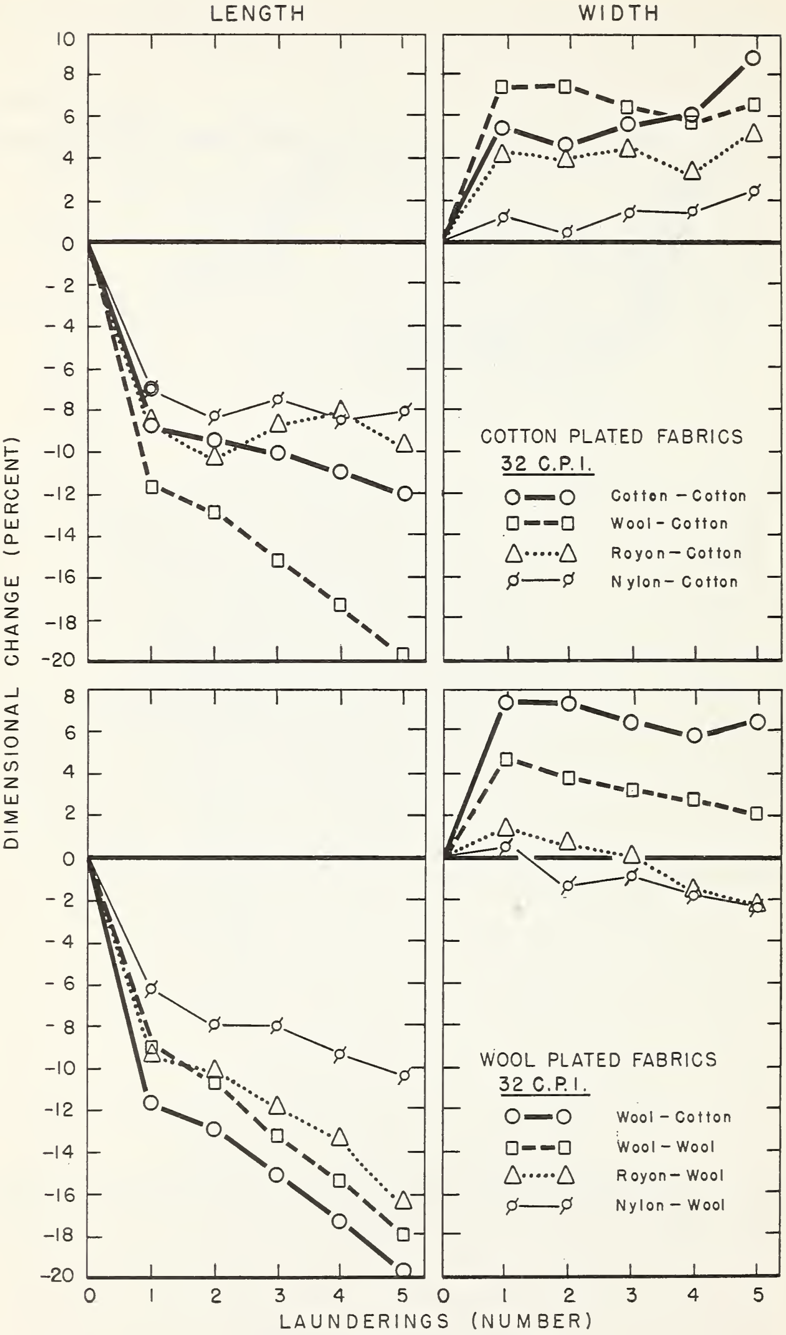

FIGURE 13.—Dimensional change in five launderings of plated fabrics knit of two fibers, 32 courses per inch: Cotton and wool, each in combination with cotton, wool, viscose rayon, and nylon.

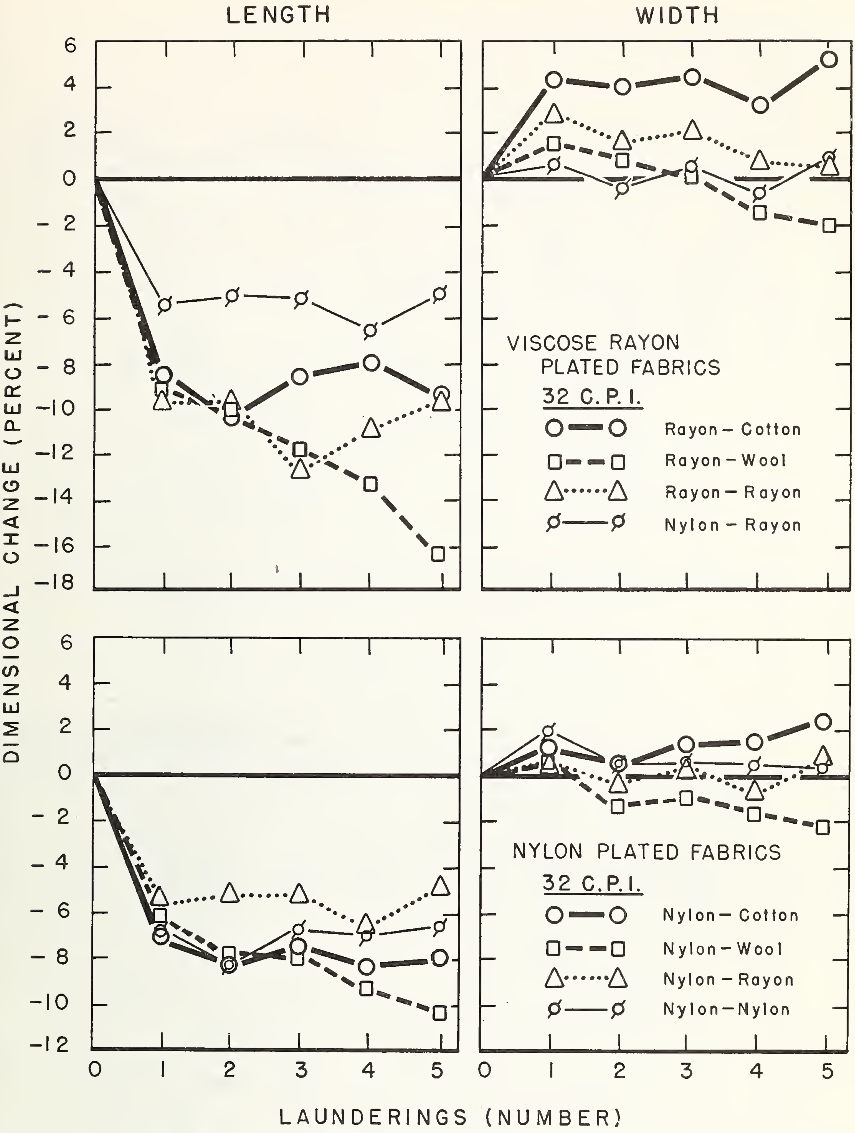

Figure 14.—Dimensional change in five launderings of plated fabrics knit of two fibers, 32 courses per inch: Viscose rayon and nylon, each in combination with cotton, wool, viscose rayon, and nylon.

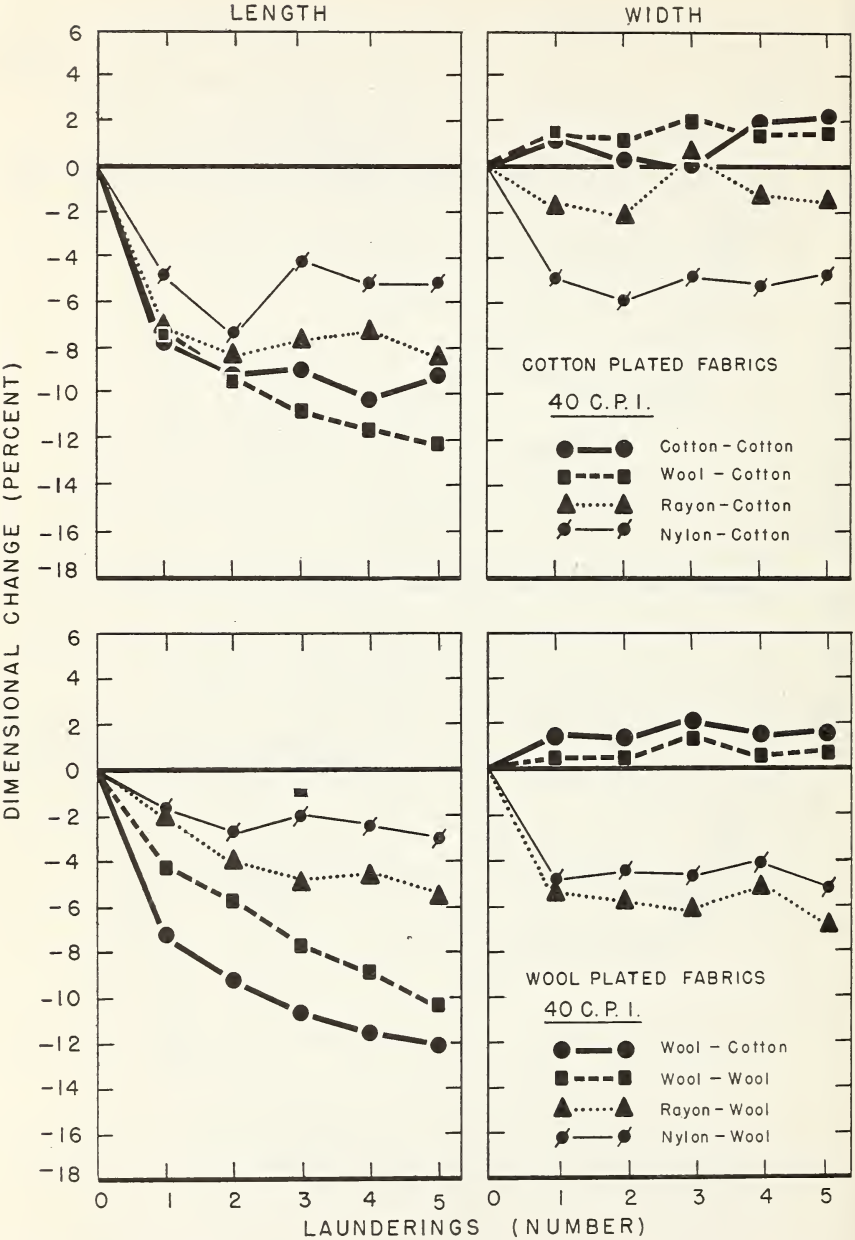

FIGURE 15.—Dimensional change in five launderings of plated fabrics knit of two fibers, 40 courses per inch: Cotton and wool, each in combination with cotton, wool, viscose rayon, and nylon.

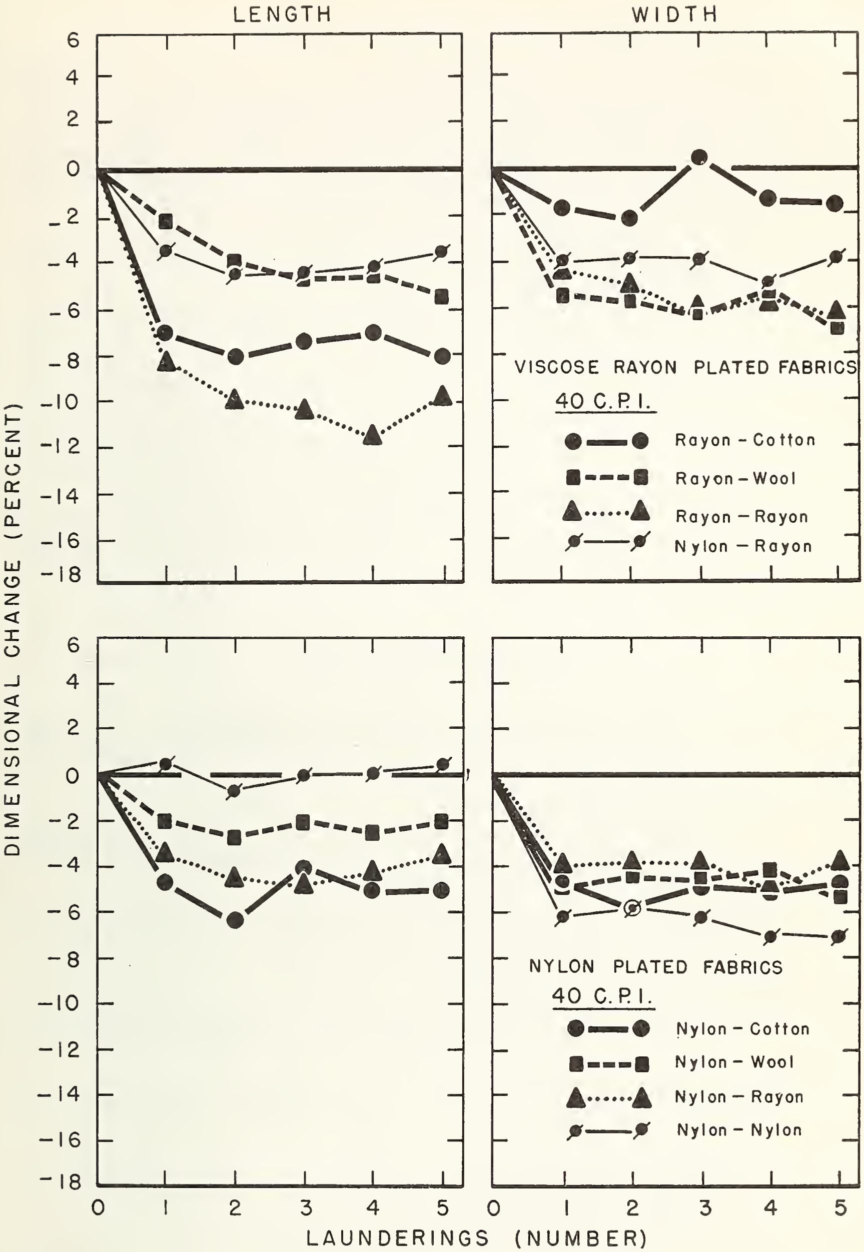

FIGURE 16.—Dimensional change in five launderings of plated fabrics knit of two fibers, 40 courses per inch: Viscose rayon and nylon, each in combination with cotton, wool, viscose rayon, and nylon.

Change in Area in Laundering

The plated fabrics of all-cotton, all-wool, and all-nylon decreased less in area in laundering than the plain knit materials, but the viscose rayon decreased more (fig. 17). Of the plated wool and nylon fabrics, those knit with 40 courses decreased less than those of 32 courses, whereas the cotton and viscose rayon fabrics of 40 courses decreased more than those of 32 courses.

The wool fabrics in both groups decreased progressively in area with all five launderings. The others showed no further decrease after the second and third washings.

All knit fabrics, both plated and plain, decreased in area in laundering, except the plain knit rayon of 32 courses per inch (fig. 17). Most of the plated fabrics of the 10 combinations of cotton, wool, viscose rayon, and nylon knit of 32 and 40 courses per inch exhibited decreases in area in laundering ranging from 5 to 12 percent (figs. 18, 19). Only the wool combinations and the rayon-rayon fabric knit with 40 courses per inch decreased more than 12 percent. The wool combinations of 32 courses per inch decreased considerably more in area than those of 40 courses per inch (fig. 18). In the other three groups the majority of the fabrics knit with 32 courses per inch differed little from those of 40 courses.

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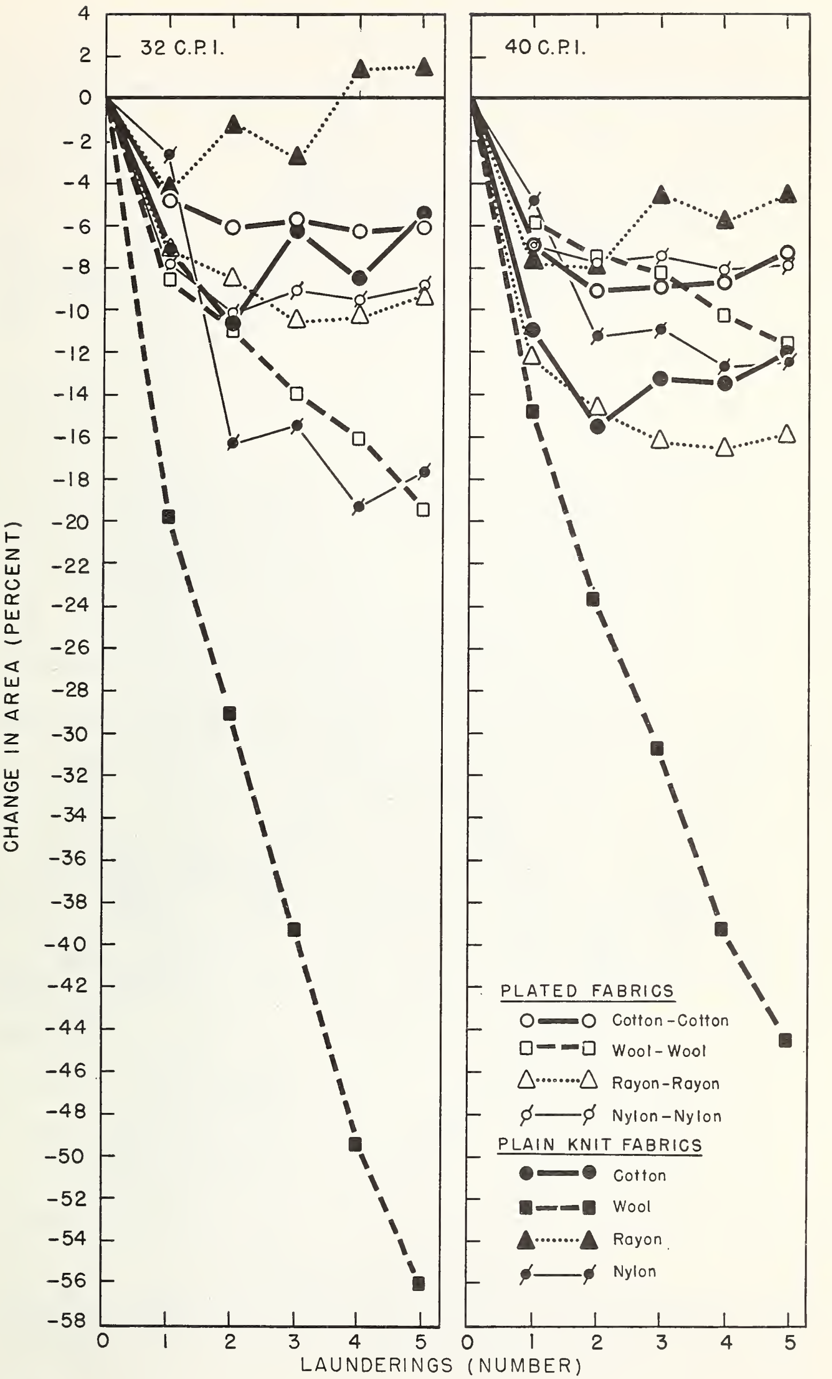

FIGURE 17.—Change in area in five launderings of plated fabrics knit entirely of one fiber and plain knit fabrics, 32 and 40 courses per inch: Cotton, wool, viscose rayon, nylon.

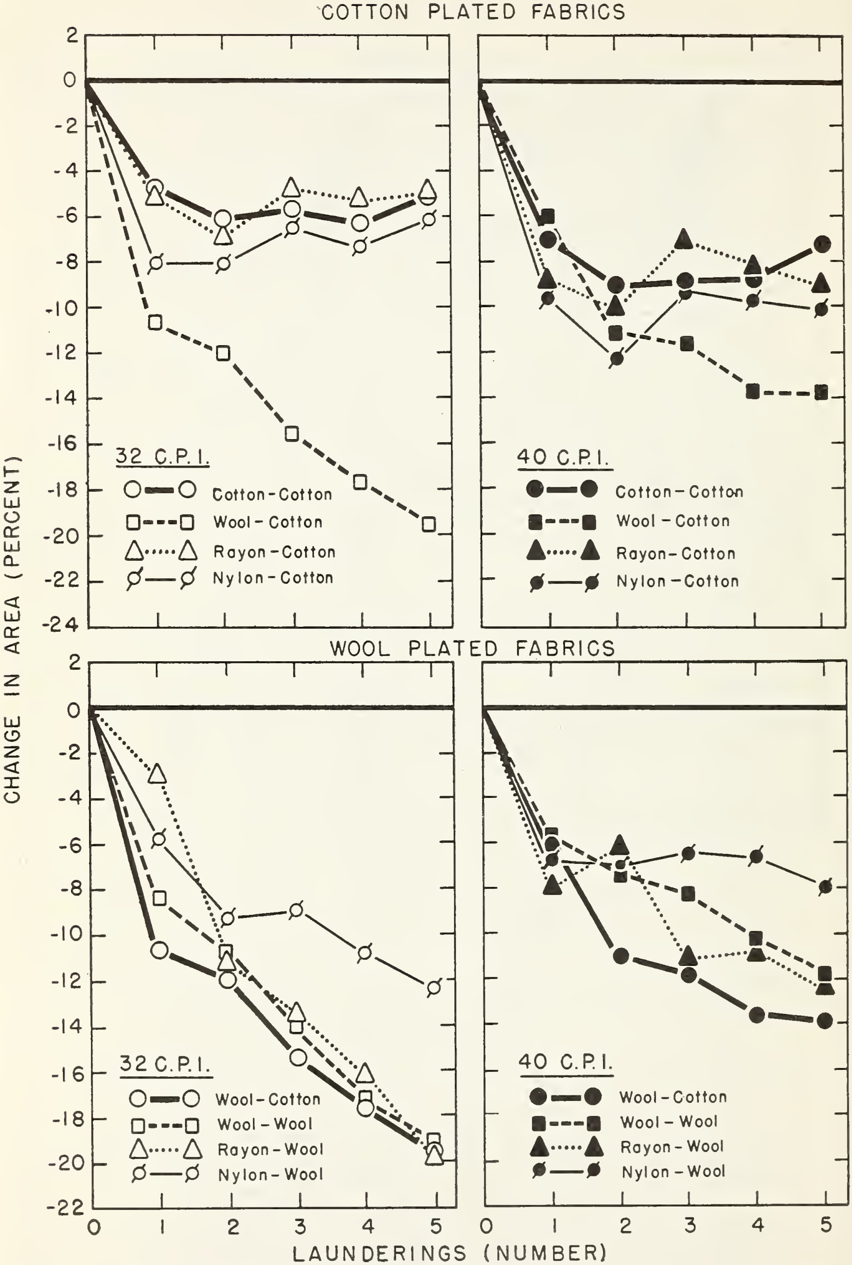

FIGURE 18.—Change in area in five launderings of plated fabrics knit of two fibers, 32 and 40 courses per inch: Cotton and wool, each in combination with cotton, wool, viscose rayon, and nylon.

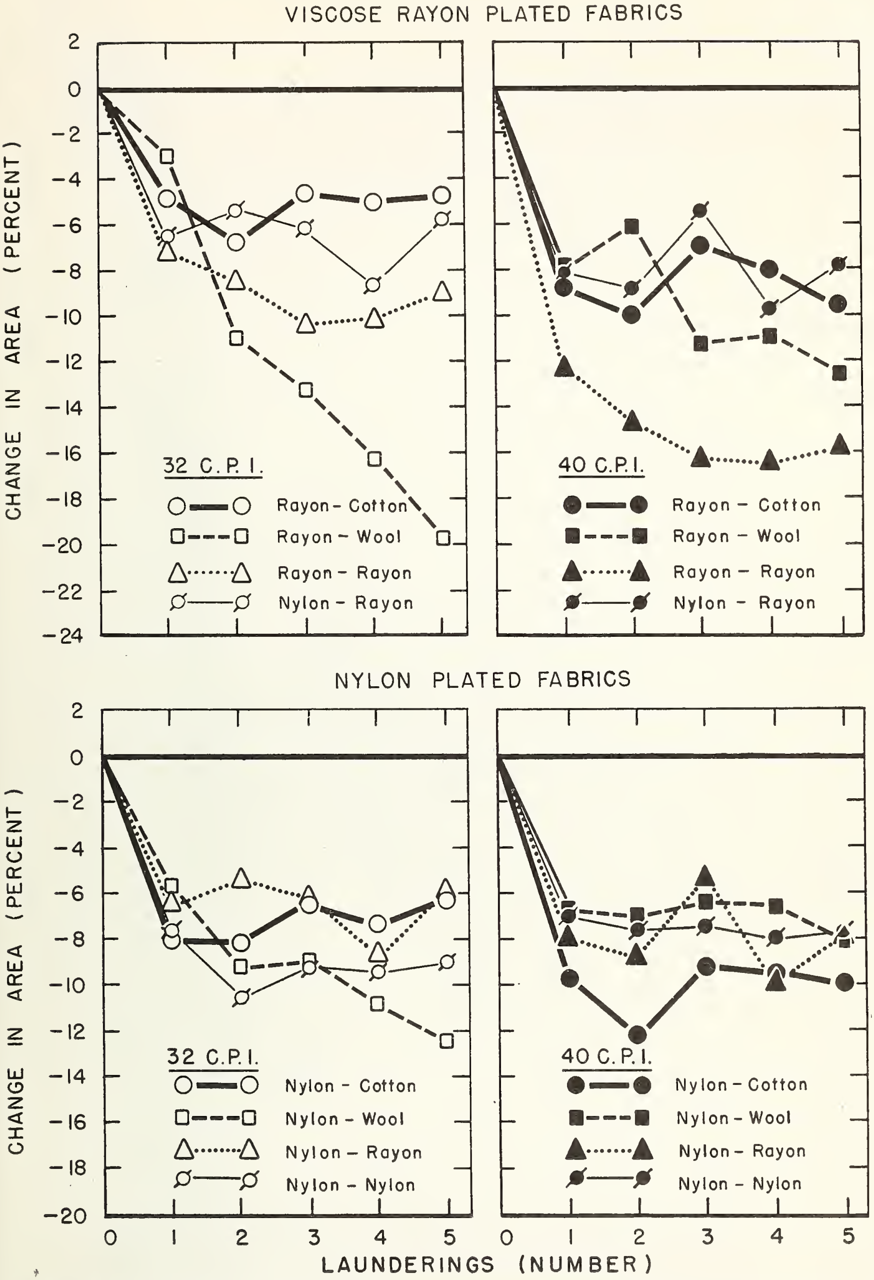

FIGURE 19.—Change in area in five launderings of plated fabrics knit of two fibers, 32 and 40 courses per inch: Viscose rayon and nylon, each in combination with cotton, wool, viscose rayon, and nylon.

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